

AD-A240 781



②

THE DYNAMICS OF CASUALTY RATE ESTIMATION, MEDICAL RESOURCE ALLOCATION, AND DISEASE AND INJURY SURVEILLANCE

C. G. BLOOD
W. M. PUGH

91-10818

DTIC
ELECTE
SEP 19 1991
S B D

REPORT No. 91-15

Approved for public release: distribution unlimited.

NAVAL HEALTH RESEARCH CENTER
P.O. BOX 85122
SAN DIEGO, CALIFORNIA 92186-5122

NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND
BETHESDA, MARYLAND



91 9 17 026

**The Dynamics of Casualty Rate Estimation, Medical Resource
Allocation, and Disease and Injury Surveillance**

Christopher G. Blood

William M. Pugh

Medical Information Systems and Operations Research Department
Naval Health Research Center
San Diego, CA

Report No. 91-15, supported by the Naval Medical Research and Development Command, Department of the Navy, under work unit No. M0095.005-6050. The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of Defense, nor the U.S. government. Approved for public release, distribution unlimited. To be presented at the Eighth International Symposium on Military Operational Research (8 ISMOR) to be held at the Royal Military College of Science, Shrivenham, Wiltshire, UK 2-6 Sept 1991. The theme of the symposium is OR's ROLE IN PREPARING FOR AND SUPPORTING THE WAR IN THE GULF.

SUMMARY

Problem

An essential component of any large scale military operation is the treatment of medical casualties. Medical readiness requires that the proper health care personnel and medical supplies be deployed to a theater of operations in sufficient numbers to accomodate the battle injuries and diseases likely to be incurred.

Objective

The present analysis outlines the dynamics of wartime casualty projections and how these projections are used to determine needed medical materiel.

Approach

The Naval Health Research Center has computed disease rates for various geographical regions, for the Navy and Marine Corps, for forces afloat and ashore. Battle injury rates for afloat and ashore operational scenarios have also been calculated. The system used to determine medical resource allocations has been examined in conjunction with the illness data collected at Navy medical treatment facilities.

Results

A number of factors which influence disease and casualty rates have been outlined in technical reports. Factors affecting disease rates include geographical region, branch of service, and battle intensity. Afloat casualty rates are significantly impacted by type of operation, weapon in attack, and ship type.

Conclusion

Medical resource planning is an integral part of any combat operation. Planners determining medical requirements for the Gulf Conflict requested all relevant information pertaining to the disease and casualty rates anticipated in the Kuwaiti theater of operations. Medical surveillance during an operation is essential to both on-line requirements programming and resource projections for future scenarios.

| | |
|--------------------------|----------------------|
| By _____ | |
| Distribution _____ | |
| Availability Codes _____ | |
| Dist | Avail and/or Special |
| A-1 | |

**The Dynamics of Casualty Rate Estimation, Medical Resource
Allocation, and Disease and Injury Surveillance**

Christopher G. Blood

William M. Pugh

INTRODUCTION

A critical component of any large scale combat operation is the handling of battle casualties. The necessary planning involves an estimation of the numbers and types of medical personnel required, the supplies needed to treat casualties, and the procedures for evacuating troops with serious disease or injury. Such planning requires accurate estimates of the number of sick and wounded that are anticipated. These projections must account for all persons that are medically incapacitated; therefore estimates of disease and non-battle injuries (DNBI), as well as battle casualties are required.

The requirement for credible DNBI rates that could be used for such planning was identified by the Chief of Naval Operations, Director of Plans and Policies. As a result, in 1987 the Naval Health Research Center (NHRC) was tasked to determine the DNBI rates for Navy and Marine Corps personnel, both afloat and ashore, for three theaters of operation. The specific theaters of interest were Northeast Asia, Southwest Asia, and Europe. In addition, projections of DNBI rates for various battle intensities were requested.

Initially inpatient and outpatient records of Navy and Marine Corps personnel stationed in, or deployed to these regions were examined. However, it was necessary to collect additional data to supplement these records because Navy and Marine Corps illness data had been combined making it impossible to derive separate rates for each service. A patient encounter form was designed to allow tabulation of service-specific injuries and was placed aboard a sample of U.S. Navy surface ships carrying both Marine Corps and Navy personnel.

NHRC was also tasked with determining the rates of casualties associated with various operational scenarios. Although this was identified as a separate task, the guidelines were similar to the DNBI study; casualty rates were to be determined for the Navy and Marine Corps, both afloat and ashore, under varying battle intensities.

MEDICAL RESOURCE PLANNING

Medical resource planning involves the determination of wartime requirements for men and materiel. Proper programming of the medical requirements for a military operation is predicated on accurate projections of the battle injuries and diseases likely to be incurred. Armed with projections of the numbers and types of medical casualties expected to be sustained during a conflict, military planners may ensure that properly trained health care personnel, and needed medical equipment and supplies are available. The critical nature of medical preparedness is underscored in several articles detailing the need for combat-ready surgeons and facilities.^{1,2,3}

DEPMEDS

In an effort to meet the goal of military medical readiness, the Department of Defense has undertaken a major initiative to address the health care needs of forces deployed in a theater of operations. This initiative, the Deployable Medical Systems project (DEPMEDS) provides deployable medical care via modular assemblages of standardized equipment and supplies⁴. Medical materiel required within the modules are determined by projecting the resources required for treatment of 319 distinct Patient Conditions (PCs) considered representative of disorders expected in an operational theater⁵. These patient conditions include the combat-induced wounds, non-battle trauma, and diseases which would be expected to tax the medical resource allocation system in a

theater of operations. Because the predicted frequencies of the patient conditions determine the make-up of the deployed modules, their importance can not be overstated. The Clinical Review Group, a quad-service committee of the Defense Medical Standardization Board (DMSB), periodically reviews the patient conditions, treatment techniques, and supply items to ensure that the policies and decisions reflect the needs of each service. Consequently, input from each service branch is necessary to determine the medical resources required for an operational scenario.

Personnel working at the Academy of Health Sciences, San Antonio have determined expected rates of occurrence and a proportional distribution of the patient conditions for an army scenario. Part of NHRC's tasking was to examine the PC codes and to indicate what the rates and distributions might be with Navy and Marine Corps scenarios.

Inpatient data of Marines that were sick or injured while deployed to Southeast Asia between 1965 and 1971 were extracted and examined. Programming code was written to convert the inpatient records, which were in ICD-9 (International Classification of Disease, Ninth Revision) format, to the Patient Condition codes. The criteria which defined the PC codes were multiple and highly specific causing many problems in the attempt to map from the ICD codes. For instance, one PC code reads "multiple fragment wound brain, multiple fragment wound chest, sucking chest wound, and pneumohemothorax". A hospital record would require four separate diagnoses in the ICD format in order to meet all these criteria. Undoubtedly, projection of very specific cases of trauma allows for the greatest precision in determining needed medical resources. However, the trade-off for such a high degree of detail is that some wounds will not meet the criteria for any one of the patient conditions.

A report was compiled⁶ that provided the rates of all PC conditions among Marines stationed in Vietnam. This report also included the ICD code equivalence of each PC category. A follow-

up report was written⁷ which detailed some of the problems encountered when mapping codes from two different diagnostic systems. Imprecise code conversions, gaps in the patient condition coding schema, and the need for further standardization in the diagnostic code schema which drives DEPMEDS were the subjects of the second report. It was pointed out that a substantial number of hospitalizations would be unaccounted for with the PC format. An alternate schema based on ICD codes was proposed⁷. Medical treatment facilities already record admissions in ICD format so use of this coding system in determining needed medical resources would ensure that all hospitalizations were included. Further, with an ICD-based system, those admissions which do not require a quantifiable amount of supplies to be allocated may be factored into the resource algorithms accordingly, while at the same time the needed bed space would not be overlooked.

DISEASE AND NON-BATTLE INJURY RATES

The Naval Health Research Center has compiled a number of reports detailing factors that affect the incidence of DNBI within military operations. Initial guidance was to focus on overall rates of incidence; therefore, NHRC provided rates of sick call visits by geographical theater⁸. Sick call visits include all visits to the dispensary regardless of whether they require inpatient admission or are treated and immediately returned to duty.

After the sick call rates were determined, data was requested on DNBI hospitalization rates (those illnesses that were serious enough to warrant admission to a medical treatment facility) and sick list admissions (illnesses in which the individual is lost to duty for 24 hours or more but not admitted to a hospital). These rates were determined for Navy⁹ and Marine Corps¹⁰ enlisted personnel, afloat and ashore, during peacetime. Additionally, outpatient rates and sick list rates from shipboard combat

operations were contrasted with DNBI rates from peacetime deployments. 11,12

Follow-up work documented the effect of combat intensity and developed a model that was used to quantify the impact of battle intensity on DNBI rates¹³. A procedure was developed to combine the battle effects with the geographical effects and project the disease and injury rates for operations in different theaters¹⁴. It was observed that the ratio of sick list admissions to inpatient admission decreased as combat intensity increased. This was believed to reflect a change in patient handling during different levels of battle intensity: During high levels of combat, individuals who otherwise would be treated as sick list admissions are evacuated, and consequently admitted to a treatment facility¹³.

BATTLE CASUALTY RATES

Because the U.S has not been involved in full scale naval warfare since the end of World War II, casualty data among shipboard forces involved in the second world war were extracted from the Operational Archives division of the Navy Historical Center in Washington, D.C. Each casualty, listed as either WIA, KIA, MIA, or DOW (wounded, killed, missing, or died of wounds), was extracted from the Bureau of Personnel casualty lists along with the ship they were deployed aboard. Also archived at the Navy Historical Center is a list of all combat operations/engagements and a record of the ships involved in each operation as well as the dates of their involvement. To determine ship populations, crew complements were collected from Navy muster rolls housed at the National Archives in Washington, D.C. The data extracted from these two archives allowed casualty rates to be computed for all afloat operations and engagements of WWII. The WIA and KIA rates across all Asia-Pacific operations were 0.30 and 0.26, respectively while the rates for European-African-Middle East operations were 0.53 and 0.31. A technical report detailing the rates for each

operation, as well as indicating the rates by each type of ship. was compiled¹⁵.

While casualty rates give an indication of how many personnel will require treatment over a specified time period, a second approach is also required to indicate the types of battle injuries that might be expected. The second approach is a "snapshot" method, which examines casualties aboard ships involved in specific wartime incidents. Again the information was extracted from the archives in Washington. Medical information was collected on the crews of 513 U.S. warships attacked during the second world war. Medical Officer Reports, After Action Reports, and Deck Logs were examined and relevant information collected on the personnel wounded in the shipboard attacks. The data was analyzed by ship type (battleships, carriers, cruisers, destroyers, and destroyer escorts) and by weapon type (bombs, torpedos, gunfire, kamikazes, and mines). Additionally, the medical information was analyzed by type of injury (fractures, penetrating wounds, burns, concussions, contusions, etc.) and anatomical regions (head, back, chest, leg, etc.). As might be expected, the distribution of injury types varied greatly between ground actions and sea warfare. For instance, while burns made up a relatively small percentage of the wounds sustained by Marines in ground action, they accounted for 21% of the wounds occurring among forces afloat. Information detailing casualty frequencies in specific 'ship by weapon type' incidents, as well as data specifying the injury distributions, were compiled into report format¹⁶. Lastly, the distribution of shipboard battle injuries was requested and made available in the ASMRO (Armed Services Medical Regulating Office) format. The ASMRO categories are used to project the patient stream and are based on the PC categories.

OPERATIONAL SUPPORT

With these work units underway, NHRC was in a unique position

to supply medical and manpower planners with information at the start of Operation Desert Shield. Among the background materials supplied to the medical planners was a summarization of the diseases prevalent in the Persian Gulf and a historical accounting of medical problems present in previous operations in the region. This study, entitled *The Impact of Diseases on Military Operations in the Persian Gulf*¹⁷, was performed by COL Norman Quin of the British Medical Liaison Office to the Surgeon General, Department of the U.S. Army.

Rate Projections

Requests were made by OP-932 (Office of the Navy Surgeon General, Plans and Policy Division), OP-06 (Plans, Policies, and Operations), Naval Medical Research and Development Command, and the Force Service Support Group (stationed in theater) for casualty estimates and projected disease incidence within the Kuwaiti Theater of Operations (KTO). The recently computed DNBI rates for Southwest Asia were provided to planners. These rates were based on naval personnel stationed in Bahrain and ships deployed to the Persian Gulf, Red Sea, and Arabian Sea. Adjustments were made to these peacetime rates to reflect the effect of combat and the resulting statistics were provided to medical planners.

Casualty rate projections, and the historical background underlying them, were also provided to medical and manpower planners. Casualty information¹⁸ detailing losses occurring in battles in the last forty years was carefully examined. Frequencies of casualties corresponding to engagements in the Persian Gulf theater were extracted and used to compute casualty rates. Rates for various tank battles taking place in desert terrain and climate were calculated for both offensive and defensive postures. Likewise, a projected casualty rate for a Marine amphibious assault, based on similar operations during World War II, was provided to planners. Rather than provide afloat casualty rates, a table was provided showing the mean casualties that might occur

for attacks by different weapons on different ships. Information was also provided detailing the percentage of conventionally inflicted wounds which would prohibit the effective use of a protective mask, either by ventilatory interference or failure of the mask to seal against the face¹⁹.

Casualty and Disease Surveillance

NHRC was also very much involved in efforts to collect data in the Kuwaiti Theater of Operations which would allow the actual rates of disease and casualty incidence to be ascertained. Beginning in September 1990, the research center worked in conjunction with the Medical Doctrine Center to develop a one-page combination DNBI/BI patient encounter form that could be fielded for use in theater. While this form was being designed and printed, NHRC placed the previously created DNBI forms on three amphibious ships that were deploying from San Diego. Upon its completion, the new data collection form which allowed recording of casualty as well as disease information, was fielded aboard the aircraft carrier Ranger and at medical treatment facilities in the Saudi theater.

Additionally, an orthopedic surgeon attached to the 1st Medical Battalion requested assistance from NHRC in the production of a TRIAGE AND TRAUMA SCORE form that had been developed in theater. Because the physicians/support staff at this treatment facility had been trained with the trauma form, the decision was made to use this form and not switch to the BI/DNBI form in use at other facilities.

EPILOGUE

Since the conclusion of the ground war, personnel at NHRC have been gathering information regarding the adequacy of medical resources in the KTO and the degree to which medical surveillance had been accomplished. The laboratory has hosted a number of

visits by physicians and staff who were deployed to the Gulf. A mini-symposium was hosted on "lessons learned" with medical planners in attendance. Additionally, Camp Pendleton, the home-base of the First Marine Division, was visited and key personnel were questioned concerning the medical logistics, disease surveillance, and casualty handling during Desert Shield/Storm.

Patient Encounter sheets and trauma forms have been returned to the Naval Health Research Center for coding and entry into electronic data bases. This data will be used to compute DNBI and battle casualty rates as well as to determine the distribution of specific diseases and injuries. These rates and illness/injury distributions, in turn, will be provided to medical planners who will consider similarity of theater parameters when projecting medical resources needed for future military operations.

REFERENCES

1. Smith, AM: Rx for contingency medical support. U. S. Naval Institute Proceedings, 113, 56-63, 1987.
2. Heydorn WH: Basic and advanced combat casualty care: A military problem. Military Medicine, 155(5), 229-31, 1990.
3. Smith AM, Bellamy RF: Conceptual errors in combat casualty care training: How to reverse them. Navy Medicine, 79(4), 15-21, 1988.
4. Burke, M: Deployable systems begin to reach field. U.S. Medicine, October 1987.
5. Galarza, JG: Using the deployable medical systems clinical database for materiel requirements. Presentation to Army Operations Research Symposium (AORS-XXVI), Fort Lee, VA.
6. Blood CG, Griffith DK, Nirona CB: Medical resource allocation: Injury and disease incidence Among Marines in Vietnam. San Diego, Calif.: Naval Health Research Center, 1989, Report No. 89-36.
7. Blood CG, Nirona CB, Pederson LS: Medical resource planning: The need to use a standardized diagnostic system. San Diego, Calif.: Naval Health Research Center, 1989, Report No. 89-41.
8. Blood CG, Pugh WM, Griffith DK, Nirona CB: Navy medical resource planning: rates of illness for various operational theaters. San Diego, Calif.: Naval Health Research Center, 1988, Report No. 88-42.

9. Pugh WM, White MR, Blood CG: Disease and non-battle injury rates for enlisted personnel during peacetime. San Diego, Calif.: Naval Health Research Center, Report No. 89-51, 1989.
10. Hermansen LA, White MR, Shaw EK, Pugh WM: Disease and non-battle injury rates for Marine Corps enlisted personnel during peacetime. San Diego, CA.: Naval Health Research Center, Report No. 90-10, 1990.
11. Blood CG, Nirona CB: Outpatient illness incidence aboard U.S. Navy ships during and following the Vietnam Conflict. Military Medicine, 155, 10:472-476, 1990.
12. Blood CG, Pugh WM, Pearsall DM: Comparisons of wartime and peacetime disease and non-battle injury rates aboard ships of the British Royal Navy. San Diego, Calif.: Naval Health Research Center. Report No. 91-2, 1991.
13. Pugh, WM: The effect of combat level on disease and non-battle injury. San Diego, CA: Naval Health Research Center, Report No. 90-9, 1990.
14. Pugh WM: Use of artificial intelligence techniques for medical readiness planning. San Diego, CA: Naval Health Research Center, Report No. 88-33, 1988.
15. Blood, CG: Shipboard and ground troop casualty rates among Navy and Marine Corps personnel during World War II operations. San Diego, Calif.: Naval Health Research Center, Report No. 90-16, 1990.

16. Blood CG: Analyses of battle casualties by weapon type aboard U.S. Navy warships. Military Medicine, (Accepted for publication), 1991.
17. Quin NE: The impact of diseases on military operations in the Persian Gulf, Military Medicine, 147, 1982.
18. McQuie R: Historical characteristics of combat for wargames. Bethesda, MD, US Army Concepts Analysis Agency, CAA-RP-87-2.
19. McCaughey BG, Garrick J, Kelley JB. Combat Casualties in a conventional and chemical warfare environment, Military Medicine, 153(5), 227-229, 1988.

REPORT DOCUMENTATION PAGE

| | | | | | |
|---|-------|---|---|---|-------------------------------|
| 1a. REPORT SECURITY CLASSIFICATION Unclassified | | | 1b. RESTRICTIVE MARKINGS N/A | | |
| 2a. SECURITY CLASSIFICATION AUTHORITY N/A | | | 3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited. | | |
| 2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A | | | | | |
| 4. PERFORMING ORGANIZATION REPORT NUMBER(S) Report No. 91-15 | | | 5. MONITORING ORGANIZATION REPORT NUMBER(S) | | |
| 6a. NAME OF PERFORMING ORGANIZATION Naval Health Research Center | | 6b. OFFICE SYMBOL (If applicable) Code 22 | 7a. NAME OF MONITORING ORGANIZATION Chief, Bureau of Medicine and Surgery | | |
| 6c. ADDRESS (City, State, and ZIP Code) P. O. Box 85122 San Diego, CA 92186-5122 | | | 7b. ADDRESS (City, State, and ZIP Code) Navy Department Washington, DC 20372-5120 | | |
| 8a. NAME OF FUNDING/SPONSORING ORGANIZATION Naval Medical Research and Development Command | | 8b. OFFICE SYMBOL (If applicable) | 9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER | | |
| 8c. ADDRESS (City, State, and ZIP Code) NNMC Bethesda, MD 20889-5044 | | | 10. SOURCE OF FUNDING NUMBERS | | |
| | | | PROGRAM ELEMENT NO. 63706N | PROJECT NO. M0095 | TASK NO. .005 |
| | | | WORK UNIT ACCESSION NO. | | |
| 11. TITLE (Include Security Classification) (U) The Dynamics of Casualty Rate Estimation, Medical Resource Allocation, and Disease and Injury Surveillance | | | | | |
| 12. PERSONAL AUTHOR(S) Blood, Christopher G.; Pugh, William M. | | | | | |
| 13a. TYPE OF REPORT Interim | | 13b. TIME COVERED FROM _____ TO _____ | | 14. DATE OF REPORT (Year, Month, Day) 91 July 31 | |
| 15. PAGE COUNT 15 | | | | | |
| 16. SUPPLEMENTARY NOTATION | | | | | |
| 17. COSATI CODES | | | 18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) Casualty projections, disease incidence, medical resource planning, medical surveillance, theater of operation | | |
| FIELD | GROUP | SUB-GROUP | | | |
| | | | | | |
| | | | | | |
| 19. ABSTRACT (Continue on reverse if necessary and identify by block number) Medical resource planning is an integral component of any combat operation. Determination of the needed medical personnel and supplies requires projections of the anticipated disease incidence and battle casualties. Rates of casualties and disease are then input to algorithms that calculate the required supplies and personnel for an operation. The Naval Health Research Center has computed disease and casualty rates for a number of operational scenarios and provided these rates to medical planners. Medical surveillance during an operation such as Desert Shield/Desert Storm is essential to both on-line requirements programming and resource projections for future scenarios. | | | | | |
| 20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS | | | 21. ABSTRACT SECURITY CLASSIFICATION Unclassified | | |
| 22a. NAME OF RESPONSIBLE INDIVIDUAL Christopher G. Blood | | | 22b. TELEPHONE (Include Area Code) 619-553-8393 | | 22c. OFFICE SYMBOL Code 22 |